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SCIENCE NEWS-LETTER

The Weekly Summary of Current Science

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USEFULNESS OF A HARD COUNTENANCE

A Cuban Toad That Makes a Front Door Out of Its Face

(See page 254)

Vol. XV No. 420

Congressional Reapportionment

Demography

Permanent peace, or at least a temporary armistice in the "war of quotients" is believed to have been brought about through congressional recess efforts of Senator Arthur H. Vandenburg, Republican, of Michigan, who will shortly introduce in the Senate a new congressional reapportionment bill, which, he says, "has the endorsement of many mathematical experts who heretofore have been split wide in rival camps."

The new bill, which the Senator says he will explain in detail when he introduces it, is to follow closely the "Fenn bill" which the House passed last January, but which failed of action in the Senate. It will differ from the Fenn bill, however, in that it will not specify any mathematical method to be followed in an automatic reapportionment, but will simply provide that the automatic reapportionment be made after each decennial census "according to the method used in the last apportionment" whenever congress fails to act independently.

This will make for permanence but will still give congressmen the chance to wrangle over a method to be used in any particular year.

It is believed that there may be considerable debate and discussion over the mathematical method to be used in connection with the 1930 census, but if congress does not decide definitely on the method to be used in 1930, the passage of the Vandenberg bill means that the major-fractions method would be used, as this was the method used in 1910, the last time an apportionment was made.

The advisory committee of the Census Bureau in a recent meeting, Senator Vandenberg says, unanimously voted approval of the formula in the new bill. In addition, surviving members of the old advisory committee as it existed in 1921 subscribe to it. Likewise Director William Steuart of the Census Bureau and his scientific assistant, Dr. Joseph A. Hill, approve.

"The importance of exhibits which will be submitted to the Senate in detail when the bill is introduced," stated Senator Vandenberg, "cannot be overestimated, because external division among scientific experts has been one of the main barriers to previous action. The exhibits will show the endorsement of Prof. Walter F. Wilcox of Cornell, Prof. Robert E. Chaddock of Columbia, Prof. W. I. King of New York University, Prof. George Barnett of Johns Hopkins, Prof. George F. Warren of Cornell, Prof. Edwin R. Seligman of Columbia, Prof. Carroll W. Doten of Massachusetts Technology, and Wesley C. Mitchell of Columbia.

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Faces for Front Doors

Zoology

A toad that uses its face as a door or stopper for its burrow is the interesting animal that was dug up—in the most literal sense of the word—in Cuba by Dr. Thomas Barbour, curator of reptiles and amphibians in the museum of comparative zoology of Harvard College, whose courtesy supplies the cover picture for this week's SCIENCE NEWS-LETTER.

The creature was well known to Cubans as *sapo de concha*, or shell-headed toad, because of the exceedingly hard, tough covering of the front part of its head, but it had never been found at home, and no one had any notion of the possible uses of its indurated countenance. Then one day Dr. Barbour found a field with many tube-like burrows from seven to ten inches deep. At the bottom of each burrow was one of these shell-headed toads, its head so tilted that the hardened skin fitted the hole exactly and formed a perfect defensive stopper.

Prof. William Morton Wheeler has found a number of somewhat similar adaptations, scattered at random through the animal kingdom, where the possessor of such a lid-like surface will use it as a door for its burrow. Sometimes the head, sometimes the opposite end of the body, is thus hardened against the buffets of an adverse world. Prof. Wheeler has transliterated the Greek word for barricade into a name for this phenomenon; he calls it "phragmosis".

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All of the resources of Science Service, with its staff of scientific writers and correspondents in centers of research throughout the world, are utilized in the editing of this magazine.

T. B. Effects from Germless Compound

Medicine

The characteristic tubercles or clumps of changed cells caused by the germ of tuberculosis can be produced by the injection of a chemical compound containing no germs at all, Dr. Florence R. Sabin of the Rockefeller institute for Medical Research, New York City, reported to the National Academy of Sciences. Associated with Dr. Sabin were Drs. Charles A. Doan and C. E. Forkner. Dr. Sabin is the only woman in the Academy.

Dr. Sabin's achievement is revolutionary. By it the most characteristic change produced in the body by a germ-borne disease has been obtained without the germ entering the body. This is the first time this has been done for any disease and introduces a new technique in the study of disease.

Dr. Sabin's discovery is one of the latest and startling results of the campaign for the investigation of the causes of tuberculosis in which about a hundred bacteriologists, chemists, physicians and pharmacists in all parts of the country are now engaged. This plan for cooperative research was organized by a committee of the National Tuberculosis Association, of which Dr. William C. White of the U. S. Hygienic Laboratory is chairman.

Hundreds of pounds of microbes are being grown in flasks containing the necessary nutrients and are turned over to the chemists of Yale University and other laboratories for analysis. The various fractions into which the material is separated are then tested on normal animals to discover the physiological effects of the different constituents. By this novel method of attack it is hoped to discover what the microbes are made of and what stuff it is that the creatures excrete which (*Turn to next page*)

Fly-Wing Measures Stars

Physics

Using bits of the wing of a fly, hung on a thread spun out of a rock, to measure the radiation of a star billions of miles away, sounds like a fantastic mediaeval fairy-tale. But it is sober, twentieth-century scientific fact. It is actually being done.

Dr. Charles G. Abbot, secretary of the Smithsonian Institution, told how it is being done. Light is a form of energy, and therefore can push things. Most things do not feel the push because they are too heavy. But we can see light pushing a fairly solid object pretty rapidly in the little whirligig-things in an optician's window. It takes full sunlight to do this, and full sunlight is millions of times as strong as the faint, twinkling ray from a distant star or planet.

But the fly-wing apparatus is built on essentially the same principle as the radiometer—that's the real name of the whirligig-thing in the optician's window. Bits (*Turn to next page*)

Scientists' Bodies Strong

Anthropology

The old idea of an eminent man of science as a person whose mental development is offset by a frail or neglected body is discredited by physical measurements taken on 100 of America's most distinguished scientists. These 100 men, all members of the National Academy of Sciences, have been measured by Dr. Ales Hrdlicka, noted anthropologist of the U. S. National Museum. The Academy heard Dr. Hrdlicka's report on the physique and strength of its members.

Instead of finding strong minds in weak bodies, (*Turn to next page*)

CO_2 May Help in Pneumonia

Medicine

A new method of treating pneumonia, using carbon dioxide inhalations, may result from experiments reported by Dr. Yandell Henderson of Yale University. Dr. Henderson and his associates, Prof. H. W. Haggard, G. L. Birnbaum, P. N. Coryllos and E. M. Radloff, found the treatment valuable in a certain stage in experimental pneumonia. Inhalation of carbon dioxide has recently become widespread in the treatment of patients overcome by carbon monoxide gas poisoning.

In patients after surgical operations, the collapse of the lung is a stage or factor in the development of pneumonia, which sometimes complicates recovery after operations. Dr. Henderson and his colleagues found that the same collapse is a stage in the development of pneumonia experimentally produced in animals by introducing pneumonia (*Turn to next page*)

New "Mike" Has No Diaphram

Physics

A new type of microphone, in which nothing moves except the sound waves of the speaker's voice, may eventually confront broadcasters and public speakers. The new invention, still in the experimental stage but regarded as promising, was described by Prof. Arthur L. Foley of Indiana University.

One of the favorite types of "mikes" in present use is what is known as the condenser microphone. In this a thin diaphram of metal is hung in front of a metal plate, with an air space separating them. Electrical charges accumulate on both diaphram and plate, and as the diaphram is pushed and pulled a minute fraction of an inch by each sound wave, its approach and recession causes a fluttering in the electrical charge of the plate opposite. These electrical flutterings, amplified and cast into the ether, are picked up and translated back into sound by the receivers' radio sets.

The difficulty with any microphone employing a diaphram is that the diaphram does not (*Turn to next page*)

Onion Acid Halts Disease

Plant Pathology

An acid in an onion which kills a parasitic fungus when it attempts to prey upon it, thus playing the part of a vegetable antitoxin, has been isolated and chemically identified by three Universtiy of Wisconsin scientists, Dr. J. C. Walker, Dr. K. P. Link and Dr. H. R. Angell. This discovery is believed to be the (*Turn to next page*)

Multiplication by Division

Biology

Cut most animals up and they simply die. Cut up *Lineus,* a sea-worm common along the Atlantic coast, and it merely turns into a family of little Lineuses. How it survives this terrible surgery was told by Prof. W. R. Coe, of Yale University.

Slices cut clear across the body, at any place back of (*Turn to next page*)

T. B. Effects from Germless Compounds—*Continued*

causes sound flesh and blood to degenerate into a cheesy mass of tubercles.

When the secret of the pestilential activity of these parasites of the cell is found out, the doctors will be in a position to devise methods of counteracting it, for they will no longer have to work in the dark as they do today.

The compound used by Dr. Sabin is one of the fractions extracted from the tuberculosis bacilli by Prof. Treat B. Johnson and Dr. R. J. Anderson of Yale. It consists of an oil containing phosphorus, and is a compound hitherto unknown to chemistry, although similar in composition to the fats in our foods. After twelve doses of this compound, each dose containing as much of the substance as is contained in a gram of the dried "bugs", the tissue shows lesions closely resembling those of the disease. If the injections are not continued the lesions become gradually absorbed and almost disappear in a few months.

Other fractions from the chemical analysis of the cultivated bacilli consist of fats and waxes that have a similar effect in stimulating and disintegrating the cells of living tissues. This action of this substance is similar to that of the unknown cause of cancer, since this likewise excites the cells to abnormal multiplication and later results in their destruction. The tubercle bacillus invades the living cells and there lives and multiplies. This causes the cells to enlarge to an abnormal size and shape and these clumping together form the nodules known as "tubercles". This disastrous effect is perhaps due to some substance such as these that are now being isolated, excreted by the living microbe or coming from the decomposition of their dead bodies.

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Pneumonia—*Cont'd*

germs into the lungs. Inhalation of carbon dioxide inflates the collapsed lung, thus preventing the development of pneumonia.

Dr. Henderson showed X-ray pictures of lungs that had been so collapsed. The picture also showed the rapid inflation or redistention of the lung when the experimental animal had been put into a chamber containing 5 to 7 parts of carbon dioxide in 100 parts of air. The inhalation of the carbon dioxide induces deep breathing which redistends the lung.

Dr. Henderson emphasized that the results of his experiments are not to be interpreted as promising similar relief in the cases of pneumonia which the physician meets in his practice. But the discoveries that collapse is a stage in the development of the disease and that this treatment counteracts the collapse and reinflates the pneumonic lung indicates that here is a possible new means of controlling pneumonia, which is now a big cause of death.

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"New Mike"—*Cont'd*

vibrate faithfully according to the speaker's voice or the player's instrument. The diaphram has a vibration period of its own, which it constantly tends to fall into, thus distorting the sound it is supposed to be transmitting most faithfully.

Prof. Foley's microphone has no diaphram at all, but instead solid metal plates with the usual air space between them. The sound waves of the speaker's voice are directed between these plates, causing alternating condensations and rarefactions of the air. Since the air is acting as a dielectric or insulator between the plates, these rapid changes in its density permit corresponding electrical surges to cross the space. This sets up the electrical flutter that is needed to carry the sound waves out into the ether as radio waves.

Professor Foley stated that his invention is still far from the stage where it will begin to be seen in studios. At present it lacks the sensitivity of the microphones in commercial use. But, he added, the new microphone is as good now as the present types were a few years ago, and he and his graduate students are working out improvements.

To protect the device from premature exploitation, a patent has been applied for.

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Multiplication—*Cont'd*

the creature's brain, turn into little replicas of the original worm, regenerating such organs as the cutting deprived them of.

Queer things begin to happen if a transverse slice is partly split lengthwise, leaving the pieces attached to each other by one edge. If the free ends are toward what was the head of the original worm each piece will develop a new head, but all of the pieces will keep the same tail.

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Onion Disease—*Cont'd*

first of its kind ever made.

The first clue was given by the fact that white onions were susceptible to the disease, while certain strains of colored onions were not. A search was made for some substance presest in the colored onions and absent in the white ones that would stop the growth of the fungus. This was eventually found, and upon analysis was shown to be an acid of the phenol series, known to chemists as proto-catechuic acid.

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Fly-Wing—*Cont'd*

of the wings of common flies, about one-twenty-fifth of an inch high and one-seventy-fifth of an inch broad, formed the basis of the apparatus. Three of these bits were joined together, forming a T-shaped figure. A second T was hung opposite this, with an air-space of one two-hundredfiftieth of an inch between them. They were suspended on a thread spun from melted quartz finer than a spider's web, and offering almost no resistance to twisting.

Light permitted to fall on one side of the apparatus, which had been blackened like the vanes on the optician's radiometer, made it swing round. How much it swung could be measured by a tiny light-beam reflected from a mirror mounted with the vane, to a graduated scale twenty feet distant.

With this almost unimaginably delicate apparatus it has been possible to detect the force and analyze the variety of light received from the planets, and from stars as small as 3.5 magnitude—among the smaller stars visible to the naked eye.

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Strong Bodies—*Cont'd*

Dr. Hrdlicka declared that he found strong minds linked with strong constitutions. The head, and hence presumably the brain of the Academy members, is on the average larger than the head of the average American. Intensive mental work evidently does not tend toward a shortening of the life of the worker, the ages of the scientists showed.

Altogether, far from being inferior in physique, strength, and development of the head as compared with the American population at large, the greatest scientists of the country are proved to be superiors in these matters, the anthropoligist reported.

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"Uncertainty Principle" Enters Science

Physics

The boundaries of science's delving into the very, very small have been compressed so greatly in the march of the latest theories of physics that scientists have arrived at the limits of their ability to measure accurately.

As complicated as the principle of relativity, as far reaching, some physicists believe, is this new fundamental idea of the universe called the "principle of indeterminacy or uncertainty."

The man responsible for the introduction of this disturbing idea into the flow of scientific thought was present as an inconspicuous individual among the several hundred members of the American Physical Society at its Washington meeting. His name is Prof. W. Heisenberg, and like Einstein, he is a German. This blond, smooth-shaven, reddish-faced young physicist has an almost timid manner as though he were truly unaware of the stir that his theory is sure to make when once philosophers and laymen begin their attempts at its interpretation.

Heisenberg's indetermination principle is destined to revolutionize the ideas of the universe held by scientists and laymen to an even greater extent that Einstein's relativity and the quantnm theories. Crudely stated, the new theory holds that chance rules the physical world. There is an end to the physical domain. Always as man has delved deeper and deeper into the universe's structure he has found finer and more detailed construction. Atoms showed their electrons. But now the bottom has dropped out. There is an end to knowledge not because of lack of endeavor but because of the nature of knowledge itself. Before the infinitesimal is reached, meaning ceases. The scientist has a limit to his curiosity.

Old fashioned physics conceived things as hard and solid and reliable. Measure where a baseball is and how fast it is going and it once was believed that its future position could be predicted. Roughly, that is still true, that is, true enough for practical purposes of every-day life.

But take electrons, the smallest particles of matter, and Heisenberg's uncertainty makes prediction of what they are to do in the future unreliable. In essence, the future cannot be foretold from the past or the present. These weird sounding consequences arise from the contention that a particle may have an exact place or an exact speed, but it can not have both.

To say that the future can no longer be predicted exactly is true if we wish to follow the theoretical physical into the realm of the extremely minute. Even for the most delicate and precise physical measurements that can be made the uncertainty is not enough to be detected. Prof. Heisenberg gives an example to show the order of probability that is involved.

Suppose that a weight of one gram, a thirtieth of an ounce, is thrown a hundred yards, he explains.

The principle of uncertainty says that it would not necessarily fall there. The place of its fall can be computed from the principles of mechanics. Now suppose that it is assumed that in actuality the weight falls three millimeters, about an eight of an inch, from the point (*Turn to next page*)

Universe Given Diminished Size

Astronomy—Physics

Write the number 176 and after it put a row of 18 ciphers. Then you will have the number of miles that you will have to travel if you want to completely encircle the universe and get back where you started.

Vast as this figure appears, it is about a twentieth as large as scientists supposed a few years ago. It is based on a new value of the "radius of curvature of spacetime", as the physicist calls it, that was announced to the meeting of the American Physical Society by Dr. Ludwik Silberstein.

Dr. Silberstein is a mathematical physicist connected with the research laboratory of the Eastman Kodak Company, and is considered as one of the world's leading authorities on these matters, which are closely connected with Einstein's theories.

According to Einstein and his school, space is not infinite. The old idea that one could travel in a straight line forever is wrong, they say. As a matter of fact, there is no such thing as a straight line, and if a person should travel far enough and long enough in what seems to be a straight line, he would eventually find himself back at his starting point.

Yet, they also say, space is unlimited, and this is an illustration of how that may be. If a small insect lived on the surface of the globe, and was unable to leave it, or to perceive anything else off its surface, he could travel indefinitely around it in any direction. He would never come to an end, yet his universe would be limited. Even if endowed with human intelligence, and (*Turn to next page*)

Back to Newton for Quanta

Physics

The idea that light consists of minute particles, or corpuscles, popular centuries ago, but which was abandoned during the seventeenth century, is again seeking scientific recognition. At the meeting of the American Physical Society this idea of the great Sir Isaac Newton was suggested as being true after all.

The corpuscles which compose light, as conceived by Dr. Herbert J. Brennen, Northwestern University physicist, are nothing but the electrons of matter itself. These electrons, say modern theories, form part of the atoms of which matter is made. They are also given off from a hot filament in an electric lamp. They make possible the radio vacuum tube. As cathode rays they are given off in an evacuated tube when high voltage electricity is passed through it. Recently, a General Electric scientist, Dr. W. D. Coolidge, obtained them in large quantities in the open air, outside the generating tube.

But none of these electrons travel as rapidly as light. About 150,000 miles a second is the fastest the cathode rays can be made to travel, but light will traverse 186,000 miles in a second of time. If the electrons from a cathode ray tube could be accelerated to that speed, then a beam of light, and not cathode rays, might emerge.

The wave theory of light, which has held the field without dispute until recent years, states that light consists of waves, in a hypothetical and mysterious medium called the ether. The quantum theory, which physicists have recently (*Turn to next page*)

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Universe's Size—*Cont'd*

he or his ancestors had never been able to perceive anything off the globe's surface, he would not be aware of the rest of the world about him.

Our universe, say the relativists, is similarly curved, in some fourth dimension, which the human race has so far been unable to perceive or comprehend. Apparently, we are free to move in any direction we choose, but actually there is at least one direction in which we cannot move, since we cannot comprehend it. If we could, then we could move in that direction.

But even though it cannot be comprehended, the scientist can get some faint glimmering of its existence, and estimate the size of this four-dimensional sphere in which we live. This is what Dr. Silberstein has done.

Using data pertaining to two separate groups of stars, furnished him by the Harvard College Observatory, Dr. Silberstein has made a new estimate of the radius of curvature of the universe, or "spacetime" as it is generally called. This radius is practically the same when calculated from either of the two kinds of stars. It is about a twentieth as large as a previous estimate that he made in 1924, which was based on 18 globular star clusters and the Magellanic Clouds. The latter are clouds of stars seen in the southern hemisphere of the sky. Dr. Harlow Shapley, director of the Harvard College Observatory, is now working out some new material on these objects. Though not finished, it appears that his previous estimate of their distances, which Dr. Silberstein used, was too large. Therefore, and for other weighty reasons, Dr. Silberstein believes that his new determination of the radius is the more accurate.

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Back to Newton—*Cont'd*

tended to accept, states that light consists of bursts of energy, or "quanta", but these are not the same as the corpuscles of Newton, even though they are discrete units, and not a steady series of waves. Another phase of modern physics, the so-called "wave mechanics", suggested by the German physicists Schroedinger and Heisenberg, the latter now in this country, and the French physicist the Duc de Broglie, holds that the electron itself is a wave phenomenon. If this is the case, perhaps the theory proposed by Dr. Brenner may reconcile all of the suggested theories of light.

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A young giraffe is one of the rare and difficult animals to bring to a zoo, and costs about $5,000.

An expedition to Abyssinia hopes to capture specimens of the reticulated giraffe, the largest kind of giraffe in existence.

Uncertainty—*Cont'd*

that mechanics predicts. The probability that it will do so is one time in a number so large that it would be meaningless to write it. Prof. Heisenberg expresses it as E, the base of napierian logarithms, raised to the ten septillion power, that is, E with an exponent consisting of one followed by 25 ciphers.

It is of such bewildering stuff that scientific discussions are made today. In the new idea that uncertainty rules the universe, dreamers and mystics will see the abode of their fancies; the non-existent realm beyond the limits of meaning will soon be populated by ghosts, spirits and mental shadows. This is the price that scientists often pay for progress and it will not worry them, although it may amuse and even excite the lay world.

As reinforcement of Heisenberg's principle, Dr. Arthur E. Ruark of the University of Pittsburgh, told the physicists that there exists a limit of accuracy in the measurement of lengths and he enunciated laws that resemble Heisenberg's ideas of indetermination. The relativity theory provides a limit to the velocity of all things. None can exceed that of light. In the case of length measurements, this provides an automatic accuracy limitation that, paired with the length measurement, makes the uncertainty principle applicable.

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Twenty years ago, New York City lost 4,000 children under five years of age each summer from "cholera infantum", whereas last year only 24 deaths occurred from this cause.

The "black window" is probably the most poisonous spider in orth America, according to an entomologist who has allowed many spiders to attack him.

Fruit Fly War May Be Long

Entomology

War to the knife is to be looked for in the area in Florida where the Mediterranean fruit fly has recently been discovered. Unless surveys now under way show the insect's distribution to be already too wide to make it practicable, the pest will be combated by the method used successfully a few years ago against the citrus canker in the same state—radical and ruthless destruction of every fruit and vegetable the fly can breed on, resulting in sheer race starvation. This method of protection against pests and diseases from abroad is practicable only where the infected area is not too great and where strict precautions can be maintained against new introductions. The defensive war against hoof and mouth disease in cattle has made the principle of the method familiar to the public.

The area on which the insects are known to be present comprises only about 40 square miles, but four counties and a part of a fifth have been placed under quarantine. The quarantine applies not only to citrus fruits but to all other products capable of harboring the Mediterranean fruit fly. Possible host plants make up a list of over fifty items, but Dr. Rohwer pointed out that not all of these are likely to be involved in shipments from the three counties at the present time.

The total number of bearing citrus trees of all kinds in Seminole County, according to the Florida state department of agriculture, is 314,398. In Orange County the total is 1,638,487, and in Lake County 1,251,890. For the entire state the total approaches 18 millions. Last year's value of the 14-million-box pack is over $33,000,000. A preliminary estimate sets this year's Florida citrus-fruit crop at 20,000,000 boxes.

The Mediterranean fruit fly is not content with an exclusive diet of citrus fruit, but feeds on and breeds in a large number of other fruits and many vegetable crops. Florida's annual total of fruit and truck crops, including citrus fruits, now runs well over $125,000,000. Vigorous measures for the saving of an industry of this magnitude are therefore regarded as well justified.

The Mediterranean fruit fly is a most cosmopolitan pest, and is known and hated in many lands. Though this is its first invasion of the continental United States, it has raided fruit under the American flag before, for it has been a serious liability to Hawaiian horticulturists ever since 1910.

THE MEDITERRANEAN FRUIT FLY, as drawn by a U. S. Department of Agriculture artist, enlarged about six times. The insect is about the size of an ordinary house fly

It has been known to science for about 100 years, according to workers of the U. S. Department of Agriculture. It first attracted attention in London, where oranges arriving from the Azores were found to be badly decayed and wormy. It was recorded as a pest in Spain in 1842, in Algeria in 1858, in Italy in 1863, in Sicily in 1878, and in Tunis in 1885. In 1889 it was first reported from South Africa, Western Australia became acquainted with it in 1897, eastern Australia a year later. At the turn of the century it was found near Paris, in New Zealand and in Brazil. During the next fifteen years it spread into Africa and Madagascar. The United States has escaped a visitation thus far partly by virtue of our good fortune of isolation but mostly because of the unceasing vigilance of Bureau of Entomology inspectors.

The insect is a fly, about the size and shape of an ordinary housefly but differently marked. As a matter of fact, if it were not so extraordinarily destructive, it would be regarded as a rather attractive-looking creature. It is cleanly in its habits, living solely on plant juices and on the "honeydew" secreted by certain other insects.

It is the fruit fly's larva, or grub, that is the mischief maker. The adult bores a hole in the skin of a fruit or vegetable with its egg-laying apparatus, and in this pocket deposits from one to six eggs. Sometimes several flies will lay their eggs in the same hole, accumulating as many as a hundred of the tiny white objects. Since a single fruit may be punctured in many places, the damage done is considerable.

On hatching, the larvae eat greedily and grow rapidly. At first hardly visible to the naked eye, they increase in size until the ruined fruit is obviously and disgustingly "maggoty." After resting for a time as pupae, the insects emerge full grown and ready to repeat the cycle. The generation of a Mediterranean fruit-fly, from egg to adult, is a span of from about half a month to a little over a month, depending on the weather.

The weak point in the fly's life-cycle, at which it can be most successfuly attacked, is its adult stage, especially the few days it spends flying about and feeding before it settles down to egg laying. It is susceptible to poison dusts, like calcium arsenate, such as are used against the cotton boll weevil and many other insect pests. One difficulty arises, however, in using such dusts against the fly on citrus fruits. For some obscure physiological reason, citrus fruits are hampered in their sugar-storing processes by arsenic dusts, and fruit so protected arouses complaint that it is not sweet enough. If the Mediterranean fruit fly becomes established in spite of all efforts against it, some other chemical warfare method will have to be used against it by the orange and grapefruit growers.

Like almost all insects, the fly has its natural enemies. Four minute wasp-like insects that parasitize it have been introduced in Hawaii, and although they are not expected to wipe it out they are recognized as useful auxiliaries in man's warfare against the pest.

The Mediterranean fruit fly that has invaded the Florida fruit and truck country is an undesirable alien and all good Americans stand and applaud the efforts of U. S. Department of Agriculture and Florida State scientists and officers to oust him. But according to Dr. A. L. Quaintance of the Bureau of Entomology, we have some 100 per cent. American fruit flies of our own, of whose activities we have no right to be a bit proud. As a matter of (*Turn to next page*)

Fruit Fly War May be Long—*Continued*

fact, federal and state entomological workers combat them as furiously as though they were outside a quota and were trying to slip past the gate.

There is a cherry fruit fly and an apple fruit fly, a fruit fly that plagues currants and gooseberries, and a whole ill cousinship of them. The apple fruit fly is at present making a good deal of a nuisance of itself in commercial blueberry plantations, and is having to be fought with arsenate dusts spread by the most approved chemical warfare methods. It does not do much damage to commercial apple orchards, because the sprayings they regularly receive against the much worst pest, the codling moth, wipes out the fruit fly as an incident of the battle.

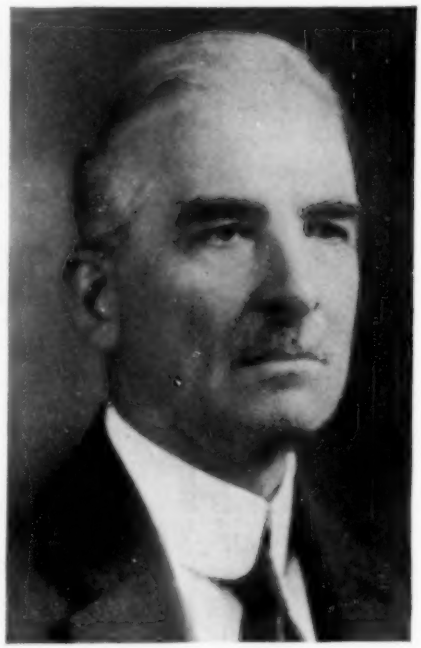
A Rio Grande patrol, not by soldiers but by entomologists, guards the United States against an enemy more to be dreaded than any number of dusky bandits or insurrectos. For the Mexican fruit fly, a close relative of the Mediterranean fruit fly, is quite as evil a customer as its old-world relative and quite as little to be desired as an immigrant.

The corps of American entomologists who maintain this "Wacht am Rio Grande" have one advantage over the Army. There is no objection to their crossing the border; on the contrary they are welcomed by the Mexican authorities, and they maintain a laboratory in the Mexican capital.

The principal center of the border guard against the Mexican fruit fly is at Brownsville, but the entomological scouts range the whole border. In addition to the U. S. Federal workers, the very much interested state of California annually sends an entomologist into Mexico to look over the fruit fly situation.

This Watch on the Rio Grande is nowhere as costly as a military guard, though it probably prevents a great deal more damage. The annual appropriation for entomological investigation is usually between $20,000 and $25,000, and the cost of maintaining the quarantine runs about $100,000 a year.

Science News-Letter, April 27, 1929



DR. C. L. MARLATT, chief of the Bureau of Entomology, U. S. Department of Agriculture, field-marshal over the scientific army that holds invading insect pests at bay

Florida and U. S. Cooperate

Entomology

The State of Florida and the U. S. Department of Agriculture, through its bureau of entomology, will be close allies in the impending war of eradication against the Mediterranean fruit fly, the destructive alien pest that has invaded Florida citrus groves in the vicinity of Orlando. This was announced to Science Service by Dr. C. L. Marlatt, chief of the bureau of entomology.

The alliance is like the association of the defending armies in the late war, in that a single officer has been appointed to the command of the joint forces. This is Dr. Wilmon Newell, of Gainesville, plant commissioner of the Florida State Plant Board, dean of the state agricultural college and director of the state experiment station.

The war is to be one of absolute eradication, Dr. Marlatt emphasized. It will involve the complete destruction of all fruit in the area known to be infested, though the trees themselves will not have to be destroyed. Useless trees, however, such as grow in neglected back yards or straggle in real estate subdivisions that were once orchards but are not now cultivated, will be given to the ax.

As yet no estimate has been prepared of either the cost of the campaign or of the amount of fruit that will have to be destroyed. The fight is in its first emergency stages, and funds on hand for emergency purposes are being used by both state and federal authorities. Many members of congress have expressed an anxious interest in the situation, and a special appropriation will probably be proposed. Its amount, however, has not yet been determined.

"We all have a full appreciation of the gravity of the situation, but there is no occasion for or evidence of panic."

Thus J. H. Montgomery, assistant plant commissioner of the Florida State Plant Board, summed up the Mediterranean fruit fly situation as seen by Florida scientists and agricultural administrators.

"The fly was discovered in Orlando," Mr. Montgomery said. "It is still confined to the vicinity of that city, and at no place is more than six miles away. The state quarantine covers a much wider territory, however. It applies to all fruits and vegetables which might harbor the fly's eggs and thereby increase its spread.

"This state quarantine is designed to safeguard not only the rest of Florida but other states as well.

"There are now fifty state and ten federal inspectors at work, and the joint state and federal funds now available take care of the immediate situation. There is no thought in the minds of either the officials or the public except complete eradication of the pest."

Science News-Letter, April 27, 1929

Strange Changelings

Entomology

E. G. REINHARDT, in *The Witchery of Wasps* (Century):

There is a curious belief common in China and India concerning a species of mud-wasp which builds its clay nests in houses and stores the cells with caterpillars. The early observers never suspected that the caterpillars were placed there as food for a larva which would hatch from an egg deposited in the cell by the mother wasp. With characteristic Oriental mysticism they thought that the wasp had adopted a caterpillar for its child, which by appropriate incantations it would magically transform into a wasp. The story goes that the foster-parent would select a caterpillar, carefully install it in a clay nest, and, while plastering up the opening, would hum a mysterious chant over it. This song would start a slow transformation in the caterpillar. In the silent grave throughout the winter the marvelous transformation would continue, and in the spring a perfect winged wasp would emerge!

Science News-Letter, April 27, 1929

How Triceratops Used Its Head

Paleontology

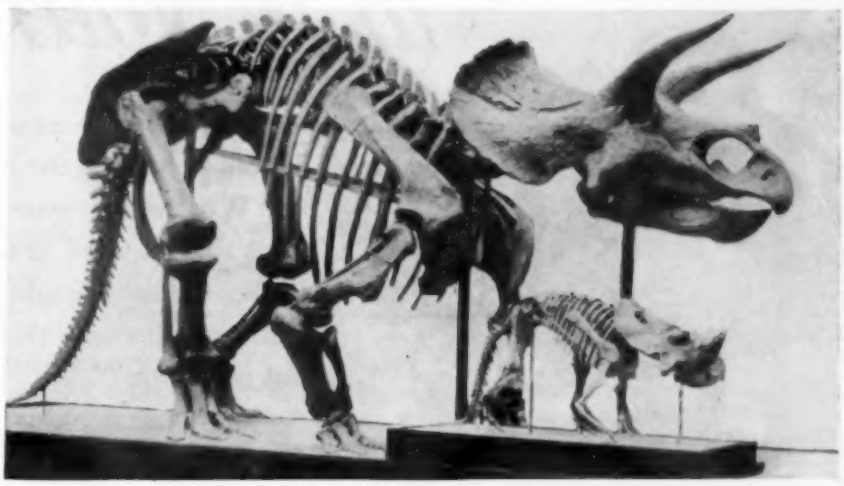
By JOHN TAIT

Dr. Tait is professor of physiology at McGill University.

Among the dinosaurs the rhinoceros-like Triceratops has long perplexed ingenious palaeontologists, who have vied with each other in suggesting a use for its formidable looking head. It appears that the problem has at last been solved, and that by means which are plain and simple, when once the proper clue has been obtained. The result is that we can now form a fairly clear picture of the behaviour of the animal and of the unique means by which it contrived to secure its food.

While Triceratops was the largest of the horned dinosaurs, it had numerous relatives, which differed from it in size, in the number of horns they bore, and in other particulars of bodily conformation. All of these "Ceratopsia" were vegetable feeders. All had a narrow mouth with a parrotlike beak. The earliest and most primitive of them, obtained from the Gobi desert by the Third Asiatic Expedition of the American Museum of Natural History, were somewhat slender animals, three or four feet in length, quite hornless, but with the disproportionately large head that is so characteristic of the gigantic Triceratops. The head of all members of the group was shaped like a plowshare pointed in front and broadly expanded behind.

The great size of Triceratops suggests that it fed on abundant herbage; its primitive teeth indicate that the food was succulent rather than woody; its small mouth opening would imply that it had access to large quantities at a time. These facts in turn suggest that it was by some means able to reach the luxuriant foliage that crowned the tall fern-stems and other similar plants of the time. Its body, carried high behind and low in front, indicates that with its powerful beak it attacked the stems near their base and brought its food down from above. Its sturdy fore-limbs, carried out laterally, braced its body on either side in front. Four of its neck vertebrae were fused together into a solid horizontal post, at the end of which the great head articulated by a mobile ball and socket joint. Consequently the inference was drawn that it twisted its head sharply to one or other side, making movements like those that we make when we signify dissent.



SKELETON OF TRICERATOPS, with one of its smaller one-horned relatives from the Gobi desert, in the U. S. National Museum, Washington. Note how the front legs were braced far apart to steady the huge bulk of the monster

DIAGRAM OF SKULL of a horned dinosaur, by Prof. Tait and Dr. Barnum Brown, showing how the spinal cord was exposed, permitting the huge head to be turned on a stiff neck

No living animal can thus rotate its head at the end of a neck held fixed, for the spinal cord, as it emerges from the brain, would by scissorlike action be inevitably divided by the closely contiguous rings of surrounding bone. It appears, however, that Triceratops and all its plowshare-headed relatives had a special provision to prevent this very eventuality. At its place of exit from the brain cavity, the spinal cord of these animals was for a considerable distance—almost a full foot in the case of Triceratops—quite bare of bony roof. Thus the head was free to be acutely rotated at the end of its rigid neck post. The broad skull-plate, carried in sloping direction upward and backward from the shovel-shaped snout, served two purposes. It gave an expanded attachment to the powerful rotatory and head-elevating muscles and at the same time acted as a very important shield to the unprotected region of the spinal cord. These animals were thus able to execute very bizarre movements of the head, first cocking their eye upwards somewhat like a hen viewing a hawk, but without simultaneously twisting their neck, and then drawing their beak sideways athwart the body until the other eye in turn looked upwards.

In the process of feeding, the smaller Gobi desert forms apparently plucked vegetable stems by a sharp lateral movement of the head and, continuing to maintain their hold, proceeded, like a rabbit eating a proffered dandelion leaf, to chew the whole stem from base to tip. The giant, horned forms, like Triceratops, probably went to work in rather a different way. Their business being to secure the top foliage of stouter and stronger vegetation, they probably first mowed a sheaf of fern or cycad stems by shearing each individual stem of a cluster, the nasal horn possibly being used as a rake in thrusting severed stems farther to one side.

As other features of the organization of Triceratops fit in with this conception, future illustrations of the restored animals may perhaps show them at work, with their heads twisted in extraordinary and almost comic fashion either to right or to left, seizing with their beaks the great stems of plants and forcibly mowing down swathes of lofty vegetation.

Science News-Letter, April 27, 1929

Are you blindly groping for words to fit your thoughts?

"What word conveys the exact shade of meaning I desire?"
"Is there a better word than the one I am using?"
"What is that word I have forgotten?"
"Is there a word in the language which expresses my thought clearly?"
"How can I avoid this constant repetition?"

STRANGE, isn't it, with all the marvelous wealth of our English language that you should find yourself groping blindly for the answers to such word questions as those above.

Strange, with a language so full of expressive words, that it should be so difficult to find the ones that express your thoughts clearly.

With more than 150 words describing various shades of beauty, or over 400 words denoting various degrees of goodness, for instance, why should it be so hard to find the best one for your purpose?

Yet it is not strange either, when you consider that dictionaries are arranged on the assumption that you know all of the more than 200,000 words in the language and seek merely their definitions—that all attempts to make the language available stopped with merely listing the words by ideas, and then not always in alphabetical order.

No wonder the average working vocabulary is less than 2500 words—that you find it so difficult to express your thoughts and your most powerful ideas become mere vague impressions in the minds of your listeners or readers.

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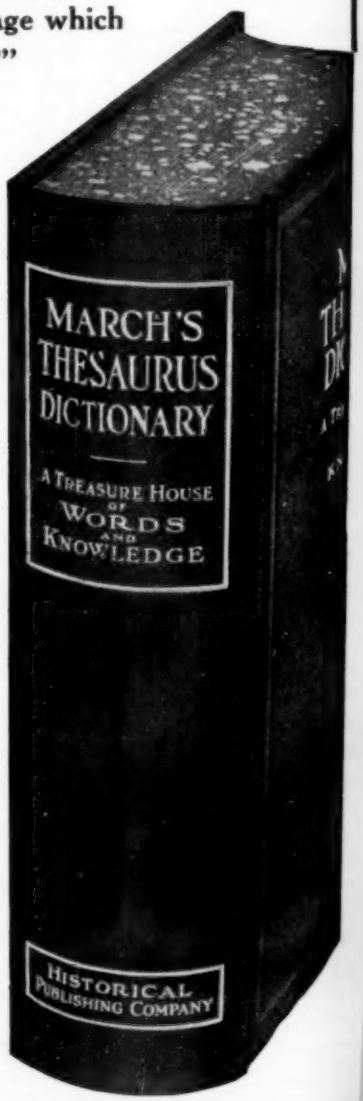

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Man's Evolution

Anthropology

Man, until now almost as passive a plaything of the evolutionary forces as the animals beneath him, may in the future be expected to take a hand in the directing of his own development.

This was the central theme of an evening address by Dr. Ales Hrdlicka, anthropologist of the U. S. National Museum, before the meeting of the American Philosophical Society.

"Man has given and still is giving a vast amount of thought to his life after death, but only relatively little to his future on this earth," said Dr. Hrdlicka. "The latter attitude, however, is undergoing a substantial change, due to the teachings of evolution.

"When the most earnest and competent students of Man are asked 'What about human evolution,' they can only answer that, while many of the details are still unknown or uncertain, and while here and there an impatient scientific worker may express some revolutionary hypothesis, nevertheless, in general, of all the major natural facts, none today is better documented and better established."

Man will be able to do something toward the shaping of his new body, but his greatest influence will make itself felt in the (*Turn to next page*)

Giants Made to Order

Biology

When the father of Frederick the Great wanted his regiment of oversize grenadiers, he had to send out his recruiting sergeants to coax or diknap sixfooters all over Europe. But future giant-fanciers will be able to get their giants merely by feeding infants properly adjusted doses of glandular extracts. And "internal six-footness"—intellectual super-development — may possibly be brought about in the same way.

All this, if the prophecies uttered before the American Philosophical Society by Dr. Oscar Riddle of the Carnegie Institution of Washington reach fulfillment. It will not be a case of "environment" overcoming "heredity," but rather a man-controlled readjustment of the interplay of these two forces, which has hitherto been left to chance. Recent researches on the effects of special conditions applied to the early stages of organisms have shown the feasibility of controlling development. While these have so far been applied mainly to sub-human forms of life, their application to our own race is merely a matter of time and the gathering of further data and skill in manipulation.

"To produce these changes in an individual and in a race it will of course be necessary to bring about changes in specific conditions during various stages of life and development," he continued. "Some of these special conditions will doubtless have to be applied during intrauterine—or even in preuterine—life, some in childhood, some in adolescence and some in later life. This will mean indeed a sort of super-medicine, a super-education, and a continuous and very personal application of a great body of knowledge. It will be a recurrent work, necessary in every generation, as is today all the work of education and of medicine.

"The development of a generation of giants, for example, would mean no transmission of 'inheritance' of gigantism, since no change is made in the combination of genes carried by these giants. If each next generation wants its giants it must make them, just as it must now make its educated men. But here we get a closer view of how this powerful creative work on the part of man may affect the thought and purpose of the man of tomorrow."

Science News-Letter, April 27, 1929

Iodine is distributed in small quantities throughout the animal, vegetable, and mineral kingdoms.

Elan Vital?

Chemistry

Sulfhydryl, which is made of one sulphur atom and one atom of hydrogen, is the stuff that makes possible the growth of plants and animals by the division of their cells. Since life can not continue, nor new organisms arise without cell division, this atom-pair may fairly be said to be the key-compound to life itself.

At the meeting of the American Philosophical Society, Dr. Frederick S. Hammett of the Wistar Institute explained the steps in his experimentation that have led to this important conclusion. The first hint came from the claim that lead compounds retarded the growth of cancer cells. Since a cancer is only a mass of ordinary cells gone mad about dividing, it would appear that anything that stopped their abnormal career must be something that removed from them whatever gave them the impulse to divide.

Dr. Hammett grew plant roots in solutions of lead compounds, and found that though the cells could increase in size their rate of division was markedly re- (*Turn to next page*)

Many New Elements In Sun

Astrophysics

Searching the sun's face with the spectroscope, the magic instrument of the scientist that can analyze and identify elements hundreds of millions of miles beyond the reach of his hand, a California chemist has added 23 elements to the list of the earth-ingredients known to exist in the sun. Dr. Charles E. St. John of the Mount Wilson Observatory, who conducted this work, laid his results before the meeting of the Academy.

When ordinary white light is passed through a suitably shaped crystal prism, or reflected from a finely ruled mirror-grating, it is spread out in a rainbow-colored band, or spectrum. But if a single element is heated until it shines, and that light passed through the prism, there will be merely sharply marked lines of definite colors, in mathematically predictable places.

Using this principle, and gathering light from the sun not only under normal conditions but also from its outer layers during eclipses, from the vast vortexes we call sunspots, and from points of other unusual solar behavior, Dr. St. John assembled a huge array of photographic plates showing these spectral lines which a chemist or a physicist can read. Some of them were made by parts of the sun's visible light and some by the invisible infra-red and ultra-violet radiations.

A number of the elements he identified for the first time on the sun are well known and abundant on the earth, like oxygen, sulphur and carbon; others, like hafnium, europium and gadolinium, are so rare that they are merely names even to the majority of chemists. The precious metal platinum was identified by three lines. Helium, discovered many years ago on the sun by spectroscopic method before it was found on earth, Dr. St. John relocated in disturbed parts of the solar globe.

The full list of elements added to the known chemical stock of the sun is as follows: helium, in disturbed regions; lithium, in sun-spots; boron, as boron oxide in spots; carbon, as atomic carbon; (*Turn to next page*)

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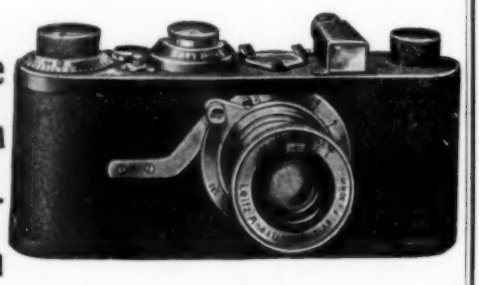

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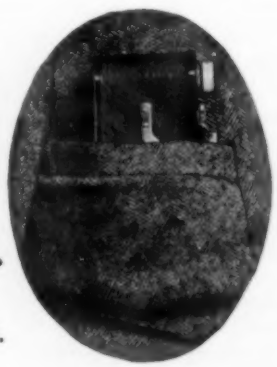

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Sun Elements—*Cont'd*

atomic nitrogen, in the infra-red; atomic oxygen, in the infra-red; sulphur, in the infra-red; gallium, germanium, rubidium, in sun-spots; rhodium, cadmium, indium, in sun-spots; antimony, caesium, samarium, curopium, gandolinium, dysprosium, erbium, ytterbium, hafnium, platinum.

There are 92 possible elements, 90 of which have so far been found on earth, Dr. St. John said. Of these, 58 have been identified in the sun's atmosphere. This does not mean that the others are not in the sun. Some of them, especially several elements which are normally gaseous on earth, have their lines far out in the ultra-violet, where, because of atmospheric interference on their way to the earth, they are absorbed and vanish before reaching the lower levels of air.

Science News-Letter, April 27, 1929

Man's Evolution—*Cont'd*

evolution of his mind, the Washington scientist declared.

"Man will slowly become ever more a helper, and in a sense a co-creator in his further evolution, particularly that of his sensory and mental faculties; and the knowledge of this will furnish, begins already to furnish him with mighty new criteria of conduct, the criteria of what will be advantageous and what adverse to this further evolution.

"The actual future changes of man can be foreseen for only a limited time to come. They will affect his stature, skull, facial parts, teeth, some of the internal organs, his arms, hands and feet; but the principal acquisitions will be, there is a strong probability, those of a higher organization, with higher effectiveness and endurance, of the brain and the sensory as well as the nervous system.

"The more important of the changes, particularly those of the brain, can not be realized easily. There are many obstacles and dangers ahead and the road of advance will be littered, as in the past and now, by the unfit.

"As to the more distant future of man, no legitimate deductions are possible."

Science News-Letter, April 27, 1929

Elan Vital—*Cont'd*

duced. In the region of most rapid growth lead precipitates appeared, which proved to be compounds of lead with the sulfhydryl group. In roots permitted to grow normally, abundant sulfhydryl was found associated with the most actively dividing cells.

A further step in the evidence was obtained when sulfhydryl-containing compounds extracted from actively growing roots were applied to the tips of other roots. Under proper chemical conditions, these compounds caused acceleration of growth. Finally, synthetic compounds containing the same pair of atoms were similarly used and produced similar results, both in root tips and in the division rate of single-celled water animalcules.

The evidence thus seems to be fairly conclusive that this pair of atoms, that tag along hand in hand like brother and sister, attaching themselves to a wide variety of other chemical compounds, are really the "life of the party" in the most literal sense of the term.

Science News-Letter, April 27, 1929

First Glances at New Books

CHRISTIAN AND JEW—Edited by Isaac Landman — *Liveright* ($3). This symposium for the better understanding of Christian and Jew is of real value in the consideration of the most prominent and perplexing racial problems of our country and our times. The 37 authors represent almost as many different points of view and express their minds freely and frankly, but all agree in expressing the spirit of good will which is the only effective solvent of such difficulties. No one can read the book without becoming both better informed and better natured. Among the contributors to the volume are: James Harvey Robinson, Henry Fairfield Osborn, Joseph Collins, Charles M. Schwab, Norman Angell, John Erskine, Edward A. Filene, Jacob Wassermann, Zona Gale, S. Parkes Cadman, Stephen S. Wise, Walter Prichard Eaton, Abram Simon, Channing Pollock, Charles P. Fagnani, Hendrik Willem van Loon, Francis P. Duffy. A Permanent Commission on Better Understanding between Christians and Jews in America has been formed to consider cases of unjust discrimination.

Sociology
Science News-Letter, April 27, 1929

THE MOTIVES OF MEN—George A. Coe—*Scribner* ($2.25). Discusses the motive power that determines an individual's attitude toward problems of industry, science and religion. The warning is sounded that: "We have entered upon a period of spiritual depression. The opinion may be ventured, moreover, that some view of human motives is going to be the turning point of every perilous issue in modern life and civilization." The volume is based on the Nathaniel Taylor lectures given by the author at the Divinity School of Yale University in 1926.

Psychology
Science News-Letter, April 27, 1929

THE ANATOMY OF EMOTION—Edward William Lazell—*Century* ($3). Principles of what might be called emotional hygiene presented to the layman. The author is to be commended for his specific handling of the subject, which gives the reader definite facts in such form that he can apply them to his own problems. The effect of the emotions on the body and the effect of physical condition on the emotions and the inextricable interplay of mind and body are stressed.

Psychology
Science News-Letter, April 27, 1929

RADIO — Irvin Stewart, Editor—*Amer. Acad. Pol. & Soc. Sci., Phila., Pa.* (Pa. $1, Cl. $1.50). Though containing two very valuable and concise chapters on the technical side of radio, one on its development by Laurens E. Whittemore and one on recent technical developments by Prof. Arthur E. Kennelly, this litte book deals more with the educational, economic and legal aspects of the subject. Dr. J. J. Tigert, former U. S. Commissioner of Education, contributes the chapter on radio in the school system; former Federal Radio Commissioner O. H. Caldwell on administration of federal radio legislation; General J. G. Harbord, president of the R. C. A., on its commercial uses and the editor on its international regulation in time of peace.

Radio
Science News-Letter, April 27, 1929

THE BASES OF MODERN SCIENCE—J. W. N. Sullivan—*Doubleday, Doran* ($2). Highlights in the history of physical science from Newton to Einstein, Weyl and Eddington, and their significance, told by a well-known English writer on popular science. The usefulness of this otherwise excellent book is limited by the lack of an index.

Physics
Science News-Letter, April 27, 1929

NEW PRACTICAL PHYSICS—Newton Henry Black and Harvey Nathaniel Davis—*Macmillan* ($1.68). A new high-school text on physics, made especially interesting and modern by the inclusion of accounts of television, talking and colored motion pictures.

Physics
Science News-Letter, April 27, 1929

COLOR AND COLOR THEORIES—Christine Ladd-Franklin — *Harcourt, Brace* ($3.50). A valuable contribution by the scientist whose theory of color has the distinction of being ranged alongside those of Helmholtz and Hering. She has here brought together the arguments against the theories of Helmholtz and Hering and has presented her own theory which includes certain features of each. Her theory of the evolution of the color-sense is of particular interest. The appendix which contains five articles on color by other scientists is a useful feature of the book, and mention should be made of the generous use of colored charts to make clear the points involved in the theories.

Psychology
Science News-Letter, April 27, 1929

NATURE RAMBLINGS

By FRANK THONE

Natural History

Friendly Toad

Shakespeare, who spent a long and active literary life getting up quotations on all possible subjects, has one for the toad, who he says is

"ugly and venomous,
"Yet wears a precious jewel in his head."

The statement is one-third strictly true, one-third strictly false, and one-third true in a sense never suspected by the naive naturalists who supplied Shakespeare with his information. There is no denying that the toad is ugly. You may even reproach the toad with his looks, and he will only maintain a pensive and injured silence. But plenty of valid evidence denies that the toad is venomous. He is not. He has not teeth and therefore could not bite even if he wanted to. He has no poison sacs in his mouth, so that even if he had teeth he would still be as harmless as a garter snake. And he is no more the cause of warts than red yarn and incantations on a dark night in a graveyard are the cure of warts. It is true, some toads do exude an ill-smelling, milky fluid from glands in their skin, which is slightly irritating to the human epidermis. But the action is so slight and so temporary that it can hardly be classed as really "venomous."

The real "jewel in his head" is his long, sticky, muscular, protrusible tongue with which he gathers in his huge daily rations of insects. As a perambulating insect trap it would be difficult to improve on a toad. He is squat, so that he can crawl under the lowest plants in the garden. He is clod-colored, and can sit for long periods as still as any clod—an indispensable virtue in a stalking huntsman. His forked tongue is as quick as forked lightning; it takes a super-fast motion picture camera to catch it in action. He is all mouth to catch his prey, and all belly to hold it, and he sticks strictly to insects.

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Problems of Mutation

Evolution

T. H. MORGAN, in *What is Darwinism?* (Norton):

There are other difficulties for the mutation theory that are still under discussion and are not to be prejudiced without further work. For example, most of the new types are less vigorout than the wild types from which they come; many of them are defective and could not possibly survive in open competition; others differ so far from the original types in one or another character as to upset the nice adjustment of the parts that is so essential to the life of the individual. Such mutants often give the impression of downward rather than upward evolution. These are difficulties that the mutation theory must meet, but it would be rash to reject the evidence because of these considerations.

For, we must remember, in the first place, that animals and plants are already so adjusted to the manifold conditions of their existence that almost any haphazard change will be deleterious. If this be generalized, it might be used equally as an argument against all theories of change—that is, against any theory of evolution. There is, however, a way out of this apparent *impasse*. The external conditions may change and the organism will then be maladjusted, and unless it can make a new adjustment it will perish. Again, at the boundaries of its usual range, new variants may be able to adjust themselves to the different conditions that there exist. It is to be remembered, too, that there is often an intimate interrelation between species. Many of them are closely bound up with the status of other species. This is especially apparent for parasite and host. Consequently any change, progressive or retrogressive, in one type will introduce a new environmental factor for others and the chain of events often has far-reaching consequences. With the appearance of new types a new opportunity arises for lower or higher types to exploit them. Furthermore, there may occur at times physiological changes that are an improvement, such as an increase in fertility, or in hardihood, or in time of reaching maturity, and so on. These changes would be difficult to detect, and as yet the mutationists have paid too little attention to them.

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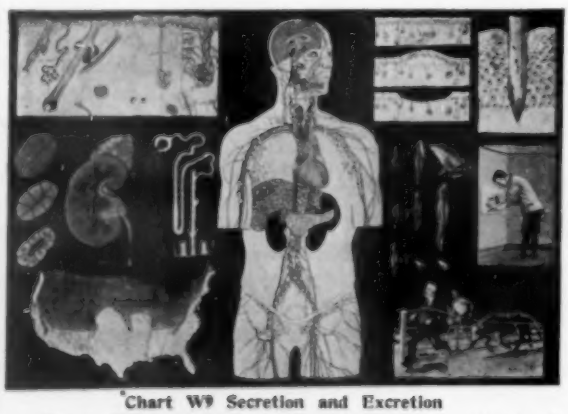

Chart W9 Secretion and Excretion

Chart W9 presents the digestive, excretory, lymphatic and endocrine glands. An appreciation of the mechanism of excretion and of representative functions of glands leads to an understanding of the needs of glands. Their hygiene also involves the care of the whole body. The temperature control and the body's protective coat are essential studies in understanding fully cleanliness, bathing and proper clothing.

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New Books—*Cont'd*

ITALY BEFORE THE ROMANS—David Randall-MacIver — *Oxford Univ. Press* (6s.). This simply written, small-sized book is like a pocket flashlight in the hazy field of pre-Roman Italy. The subject matter is so well organized that the omission of an index, ordinarily inexcusable, is not a serious inconvenience.

Archæology

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THE RAIN-MAKERS—Mary Roberts Coolidge—*Houghton Mifflin* ($4). One of those happily constructed books that manages to be encyclopedic in the ground it covers and yet is written informally enough to afford entertaining reading. The Rain-Makers are the Indians of Arizona and New Mexico. The book tells of their history, arts and industries, their social order and their mythology.

Ethnology

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HOW THE WORLD IS CLOTHED—Frank G. Carpenter—*American Book Company* (96c.). This new edition of the Industrial Readers series, which have for more than twenty years held their place in the schools, is another proof of the possibility of combining interest and instruction. Apparently the modern child enjoys reading the facts about the origin of familiar objects as he does the fiction of the old fairy tales that pedagogical conservative forces aim to read.

Economics

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A HISTORY OF MATHEMATICAL NOTATIONS; VOL. II: NOTATIONS MAINLY IN HIGHER MATHEMATICS—Florian Cajori—*Open Court* ($6). In this second volume of Professor Cajori's exhaustive work he traces the origin of such signs as pi for 3.1415 . . ., e for 2.7182 . . ., for logarithms, integrals, differentials, etc. A section is also included on the origin of $ which he concludes was derived from *ps* as an abbreviation for *pesos*.

Mathematics

Science News-Letter, April 27, 1929

MEMORIES OF LAND AND SKY—Gertrude Bacon — *Methuen & Co., Ltd., London* (7s. 6d.). Reminiscences of the first English woman to ascend in an airplane.

Aeronautics

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CLASSICS OF SCIENCE: Mystery of Mercury's Orbit

Astronomy

How the inequality of Mercury's orbit was discovered, how the only hypothesis allowed by Newton's laws of gravitation was found inadequate, and how the solution of the mystery came from an unexpected quarter.

The First Hypothesis

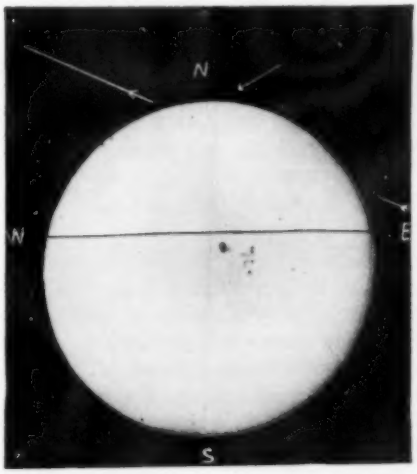
LEVERRIER'S LETTER ON THE INTERMERCURIAL PLANETS; and Faye's Remarks upon its application to the case of the Total Eclipse of July 17 (*Astron. Time*), 1860. *Cambridge* (*England*), 1860.

In my first researches on Mercury, published in 1842, the observations of the transits were not produced with such great accuracy. [One second of arc—*Ed.*] There might be observed, among many other errors, in relation to the transits of the month of May, a somewhat remarkable progressive error, which amounted to 9 seconds of arc in 1793. Such discrepancies could not be attributed to errors of observation. But, not having then revised my theory of the Sun, I thought it best to refrain from drawing any conclusion from this fact.

The use of the corrected tables of the Sun, in my new work, has not caused the errors above described to disappear entirely; systematic errors, which could not be ascribed to the observations without supposing that astronomers, such as LALANDE, CASSINI, BOUGUER, &c., had committed errors of several minutes of time, having even a progressive variation from one epoch to another,—an impossibility!

But it is worthy of remark, that an addition of thirty-eight seconds to the secular motion of the perihelion is sufficient to represent all the observations of the transits within less than a second, and even the greater part within less than half of a second. This neat result, which immediately gives to all the comparisons a precision superior to that hitherto arrived at in astronomical theories, shows that this increase of the motion of the perihelion of Mercury is indispensable, and that with it the tables of Mercury and the Sun possess all the accuracy required.

The necessity for adding thirty-eight seconds to the secular motion of the perihelion of Mercury being once admitted, let us inquire to what conclusions it will lead us. As the motion originally adopted for the perihelion proceeded from received values of the masses of the disturbing



MERCURY TRANSITING THE DISK OF THE SUN. The arrows show the position of the planet and the direction in which it is moving. The larger dark patches are sunspots

planets, we ought first to inquire what changes it would be necessary to apply to these masses in order to increase the computed motion by thirty-eight seconds. Now we perceive that this would only be possible upon one condition, namely, to increase the mass assigned to Venus *by at least a tenth* of its value. Is this alteration admissible?

If we derive the mass of Venus from the periodic perturbations which that planet occasions to the Earth's motion, we find, from the discussion of numerous meridian observations of the Sun, made between 1750 and 1810, that this mass is the *four-hundred-thousandth* part of that of the Sun. We reach the same result by taking into account the observations made between 1810 and 1850. It is the mass which we have adopted, and which it would be necessary to increase by *a tenth*, according to the discussion of the transits of Mercury over the Sun.

The perturbative action of Venus is again perceptible in the secular variation from the seven solstices observed with the greatest accuracy, from the time of BRADLEY to the present day, we find that the mass of Venus, which we have just quoted, is *a little too great,—a result contrary to that given by Mercury*. This contradiction is the point to which we are to give our attention. . . To fix our thoughts, let us consider a planet which would be situated between Mercury and the Sun, and, as we have not observed a variation in the motion of the node of the orbit of Mercury similar to that of the perihelion, let us conceive that the supposed planet moves in an orbit but little inclined to the orbit of Mercury. Let us even conceive, on account of the indeterminateness of the problem, that the orbit is circular.

As the hypothetical planet must produce a secular motion of thirty-eight seconds in the perihelion of Mercury, it follows that there is a relation between its mass and its distance from the Sun, such that, in proportion as we assume the distance to be smaller, the mass will increase, and inversely. For a distance a little less than half of the mean distance of Mercury from the Sun, the mass sought for will be equal to that of Mercury.

But is it possible such a body could exist without having ever been noticed? Assuredly it would be endowed with great brilliancy. Is it to be believed that in consequence of its slight elongation it would be always lost in the diffused light of the Sun? How conceive that we have never been struck with its brilliant light during some one of the total eclipses of the Sun? How does it happen that we have never discovered it passing over the disc of the Sun?

All these difficulties vanish upon the admission, in the place of a single planet, of the existence of a series of small bodies (corpuscles) circulating between Mercury and the Sun.

Under the *mechanical* aspect, the influence of all these small bodies would be united to produce the required motion of the perihelion of Mercury; and, supposing always that they moved in circles, they would exert no effect upon the eccentricity of the orbit of this planet. As they would form, the periodic influences which each one would exert upon Mercury would mutually destroy each other.

Under the *physical* aspect, it would not be astonishing if the regions which border on the Sun should be found to be less free than the remainder of the planetary system. Since there circulates between Jupiter and Mars a ring of small bodies, of which the largest alone have been seen in our telescopes; since everything leads us to the belief that the vicinity of the orbit of the (*Turn to next Page*)

The Mystery of Mercury's Orbit—*Continued*

Earth is furrowed by innumerable groups of asteroids, it is altogether natural to suppose that the same formation may be reproduced within the orbit of Mercury. Could any of these bodies be sufficiently noticeable to be perceived in their transits over the disc of the Sun? Astronomers, already so observant of all the phenomena which exhibit themselves upon the surface of this star, will undoubtedly find, in these reflections, an additional motive for following with attention the smallest and best defined spots. Some minutes of observation will be usefully employed in deducing their nature from observing their motions.

The Hypothesis Doubted

ASTRONOMY FOR EVERYBODY, A Popular Exposition of the Wonders of the Heavens, by Simon Newcomb. New York, 1902

Observations of transits of Mercury since 1677 have brought out one of the most perplexing facts of astronomy. The orbit of this planet is found to be slowly changing its position, its perihelion moving forward by about 43 seconds per century farther than it ought to move in consequence of the attraction of all the known planets. This deviation was discovered in 1845 by Le Verrier, celebrated as having computed the position of Neptune before it had ever been recognized in the telescope. He attributed it to the attraction of a planet, or group of planets, between Mercury and the sun. His announcement set people to looking for the supposed planet. About 1860, a Dr. Lescarbault, a country physician of France, who possessed a small telescope, thought he had seen this planet passing over the disk of the sun. But it was soon proved that he must have been mistaken. Another more experienced astronomer, who was looking at the sun on the same day, failed to see anything except an ordinary spot. It was probably this which misled the physician-astronomer. Now, for 40 years, the sun has been carefully scrutinized and photographed from day to day at several stations without anything of the sort being seen. . . .

It therefore seems certain that there can be no intramercurial much brighter than the eighth magnitude. It would take hundreds of thousands of such planets as this to produce the observed motion of Mercury. So great a number of these bodies would produce a far brighter illumination of the sky than any that we see. The result therefore seems to be conclusive against the view that the motion of the perihelion of Mercury can be produced by intramercurial planets. In addition to all these difficulties in supposing the planet to exist we have the difficulty that, if it did exist, it would produce a similar though smaller change in the position of the nodes of either Mercury or Venus, or both.

Altogether, the evidence seems conclusive against the reality of any bodies whose attraction could produce the observed deviation, which still remains unexplained. The most recent supposition on the subject is that the force of gravitation deviates slightly from the law of the inverse square. But this requires further investigation.

The Solution

RELATIVITY, the Special and General Theory, by Albert Einstein, Translated by Robert W. Lawson. New York, 1920.

If we confine the application of the theory to the case where the gravitational fields can be regarded as being weak, and in which all masses move with respect to the co-ordinate system with velocities which are small compared with the velocity of light, we then obtain as a first approximation the Newtonian theory. Thus the latter theory is obtained here without any particular assumption, whereas Newton had to introduce the hypothesis that the force of attraction between mutually attracing material points is inversely proportional to the square of the distance between them. If we increase the accuracy of the calculation, deviations from the theory of Newton make their appearance, practically all of which must nevertheless escape the test of observation owing to their smallness.

We must draw attention here to one of these deviations. According to Newton's theory, a planet moves round the sun in an ellipse, which would permanently maintain its position with respect to the fixed stars themseves and the action of the other planets under consideration. Thus, if we correct the observed motion of the planets for these two influences, and if Newton's theory be strictly correct, we ought to obtain for the orbit of the planet an ellipse, which is fixed with reference to the fixed stars. This deduction, which can be tested with great accuracy, has been confirmed for all the planets save one, with the precision that is capable of being obtained by the delicacy of observation attainable at the present time. The sole exception is Mercury, the planet which lies nearest the sun. Since the time of Leverrier, it has been known that the ellipse corresponding to the orbit of Mercury, after it has been corrected for the influences mentioned above, is not stationary with respect to the fixed stars, but that it rotates exceedingly slowly in the plane of the orbit and in the sense of the orbital motion. The value obtained for this rotary movement of the orbital ellipse was 43 seconds of arc per century, an amount ensured to be correct to within a few seconds of arc. This effect can be explained by means of classical mechanics only on the assumption of hypotheses which have little probability, and which were devised solely for this purpose.

On the basis of the general theory of relativity, it is found that the ellipse of every planet round the sun must necessarily rotate in the manner indicated above; that for all the planets, with the exception of Mercury, this rotation is too small to be detected with the delicacy of observation possible at the present time; but that in the case of Mercury it must amount to 43 seconds of arc per century, a result which is strictly in agreement with observation.

Urbain Jean Joseph Leverrier (1811-1877) elaborated Laplace's conception of the structure of the heavens, and revised the theories of all the planets. By calculation from perturbations in the orbit of Uranus he predicted the discovery of Neptune.

Simon Newcomb (1835-1909) carried out the revision of the planetary constants on a homogeneous basis, so that all astronomical results could be expressed in a comparable manner.

Albert Einstein (1879-) published the Special Theory of Relativity at the age of 26, and the General Theory ten years later.

Mercury is the smallest planet, and the nearest the sun. It is seen low in the morning or evening sky, near Venus. Its mean distance from the sun is about 36 million miles, but its orbit has greater eccentricity than that of any other planet. Its year is only 88 of our days, and its day is believed to be of the same length. This, and the improbability of any atmosphere, would make conditions on Mercury similar to those on the moon, but enormously hotter.

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Pellagra, a disease of man, and black tongue, a disease of dogs, are found to be due to the same kind of dietary deficiencies.